Specification 791 – Radiant Floors
Hydronic Radiant Heating (HRH) Systems

1. General

1.1. Summary

This draft specification is for hydronic radiant heating and/or cooling systems using PE-RT (Polyethylene of Raised Temperature) tubing. CB Supplies distributes these systems under the name VIPERT™ Radiant Heating Systems.

This draft specification is provided only as an aid in development of the final specification and is not intended as a substitute for sound architectural/engineering judgment. Specifiers shall be responsible for converting this draft specification into a final specification which meets the needs of their client and complies with all applicable codes.

1.2. References

Publications listed here are part of this specification to the extent they are referenced. Where no specific edition of the standard or publication is identified, the current edition shall apply.

a) ASTM
(*fka,* American Society for Testing and Materials)
- ASTM D2513, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
- ASTM D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
- ASTM F1807, Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing
- ASTM F1960, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing
- ASTM F2623, Standard Specification for Polyethylene of Raised Temperature (PE-RT) Systems for Non-Potable Water Applications

b) CSA
(*aka,* Canadian Standards Association)
- CSA B214, Installation Code for Hydronic Heating Systems

c) DIN
(*aka,* Deutsches Institut für Normung (German Institute for Standardization))
- DIN 4726, Plastic Piping Used in Warm Water Floor Heating (Warmwasser-Fußbodenheizungen und Heizkörperanbindungen - Rohrleitungen aus Kunststoffen)

d) ISO/IEC
(*aka,* International Organization for Standardization/International Electrotechnical Commission)

- ISO/IEC 17020, Conformity assessment — Requirements for the operation of various types of bodies performing inspection
- ISO/IEC 17065, Conformity Assessment – Requirements for Bodies Certifying Products, Processes, and Services

e) NSF International
(*fka,* National Sanitation Foundation)
- NSF/ANSI 14, Plastics Piping System Components and Related Materials

f) PPI
(*aka,* Plastics Pipe Institute)
- PPI TR-3, Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe
- PPI TR-4, PPI HSB Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe

g) UL
(*aka,* Underwriters Laboratories)
- ANSI/UL 263, Standard Fire Tests of Building Construction and Materials

h) ULC
(*aka,* Underwriters Laboratories of Canada)
- CAN/ULC S102.2, Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials
- CAN/ULC S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials

2. Definitions

2.1. PE-RT is a polyethylene (PE) resin in which the molecular architecture has been designed such that a sufficient number of tie chains are incorporated to allow operation at elevated or raised temperatures (RT). Tie chains "tie" together the crystalline structures in the polymer, resulting in improved properties such as elevated temperature strength and performance, chemical resistance, and resistance to slow crack growth. Because these tie chains grant exceptional performance properties without the need for crosslinking, PE-RT remains a thermoplastic polymer, with a significantly reduced environmental impact compared to piping materials with equivalent performance.

3. System Description

3.1. Design Requirements

a) Tubing shall carry recommended hydrostatic pressure ratings for water in accordance with PPI TR-3 and shall be made from resin named in PPI TR-4 as having met PPI TR-3 and ASTM D2837/D2513 policy for substantiation.

b) Tubing stress rupture data must confirm the following hydrostatic ratings at 73°F regression to be linear to 50 years:
- Hydrostatic design basis (HDB) of 1250 psi.
- Hydrostatic design stress (HDS) of 800 psi.

- Nominal water pressure rating (PR) of 200 psi.

c) Performance requirements: Supply a radiant floor heating system manufactured and installed in line with the specification of standard associations and ensure the continuity of the performance characteristics specified by the manufacturer without defects and failures.

4. Submittals

4.1. Approval and/or acceptance of all submittals is required prior to fabrication.

4.2. Product Data

a) Provide submittals and shop drawings in accordance with the general requirements and as specified herein. Submit shop drawings indicating the schematic layout of the system including equipment.

b) Submit computer-generated radiant floor heating system design indicating pipe sizing and panel performance at pipe spacing and water temperatures selected. Radiant floor heating calculations are to be performed on the pipe manufacturer's software.

c) Submit catalog data on all equipment, fittings, fasteners, and associated items, necessary for the installation of the piping and manifolds.

4.3. Certification

a) Tubing shall be third-party certified to applicable referenced standards and hold active listings with an organization accredited to ISO/IEC 17065.

b) The design shall be approved by a professional appropriately licensed in the jurisdiction where the installation will take place, as being complete and accurate.

c) Fittings shall be third-party certified to applicable referenced standards and hold active listings with an organization accredited to ISO/IEC 17065.

4.4. Samples

a) A sufficient quantity of tubing or fittings, as agreed upon by the purchaser and the seller, shall be selected and tested to determine conformance with applicable standards.

b) In the case of no prior agreement, random samples selected by an organization accredited to ISO/IEC 17020 shall be deemed adequate.

4.5. Quality Assurance

a) Manufacturer must be a Canadian company specializing in the work of this section with a minimum of 5 years documented experience.

b) PE-RT tubing shall be manufactured in a facility which is subject to random third-party audits by at least two organizations accredited to ISO/IEC 17020.

c) PE-RT tubing shall be third-party certified to ASTM F2623 and hold active listings with at least two organizations accredited to ISO/IEC 17065.

4.6. Warranty

a) Provide manufacturer's standard written warranty.

- The tubing manufacturer shall warrant the polyethylene of raised temperature tubing and all associated fittings they have supplied to be free from defects in material and workmanship for a period of twenty-five (25) years.

4.7. Delivery, Storage, and Handling

a) Deliver and store tubing and equipment in shipping containers with labeling in place.
- Tubing and fittings shall be kept in original packaging until required for installation.

b) Store tubing and equipment in a safe place, dry, enclosed, under cover, in a well-ventilated area.
- Do not store tubing where exposed to ultraviolet light.
- Protect tubing and manifolds from entry of contaminating materials. Install suitable plugs in open pipe ends until installation.
- Where possible, connect tubing to assembled manifolds to eliminate possibility of contaminants and cross-connections.
- Tubing shall not be dragged across the ground or other surfaces and shall be stored on a flat surface with no sharp edges.

c) Protect materials from damage by other trades.

d) Tubing shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by the manufacturer.

5. Products

5.1. Acceptable Manufacturer

a) CB Supplies Ltd, 3325 190th Street, Surrey, BC, V3Z 1A7, Canada; email: salesinfo@cbsupplies.ca; website: http://cbsupplies.ca; upon whose products and equipment these specifications are based.

b) All components of the hydronic radiant heating and/or cooling system shall be sourced from one supplier.

c) No substitutions allowed.

5.2. Piping

a) All radiant heating and/or cooling pipe shall be polyethylene of raised temperature (PE-RT) tubing.

b) Oxygen barrier tubing must be covered by an oxygen barrier capable of limiting oxygen diffusion through the pipe to less than 0.10g/m^3/day at 40^{o}C water temperature, per DIN 4726.

c) Tubing shall conform to SDR-9 CTS dimensions and be certified to ASTM F2623 by a third-party testing organization accredited to ISO/IEC 17065.

d) Tubing shall have a pressure rating of 200 psi at 73°F (23°C) and 100 psi at 180°F (82°C).

e) Bend Radius

- Tubing shall be bent at room temperature without the use of bending tools down to a minimum bending radius of six (6) times the outside diameter.
- Normal precautions shall be taken to avoid buckling or flattening. The tubing shall be fixed by supports on both sides of the bend at installation.

f) Tubing shall be third-party certified to the following standards with active listings through an organization accredited to ISO/IEC 17065:
- ANSI/UL 263
- UL Design No. L588 — 1 hour wood frame floor/ceiling assemblies
- UL Design No. K917 — 2 hour concrete floor/ceiling assemblies
- UL Design No. U383 — 1 hour wood stud/gypsum wallboard wall assemblies
- UL Design No. V461 — 1 hour steel stud/gypsum wallboard wall assemblies

g) Tubing shall have a ≤25 Flame Spread Index (FSI) and a ≤50 Smoke Developed Index (SDI) listing to ASTM E84 and CAN/ULC S102.2. This listing may require the pipe to be installed in a rated insulation material.

5.3. Manifolds

a) Distribution manifolds shall be manufactured of stainless steel and be supplied by the piping manufacturer as a proven cataloged part of the manufacturer's system.

b) Stainless steel manifolds must be preassembled and have supply and return isolation valves each equipped with a thermometer. The supply header will have flow indicator gauges for each circuit permitting calibration.

c) Manifold trade name: CB Supplies / Ivar

d) Supply and return headers must have an automatic and a manual air flow vent and both must have a fill valve.

5.4. Manifold Fittings

a) Compression nut manifold fittings shall be manufactured of corrosion-resistant brass with a barbed insert and a reusable split compression ring.

b) Fittings shall be supplied by the piping manufacturer as part of a proven cataloged system.

c) Fittings shall be third-party certified to applicable standards ASTM F1807/F1960, and NSF/ANSI 14, in active listings with an organization accredited to ISO/IEC 17065.

d) Use only continuous lengths of tubing embedded within the thermal mass or encased behind walls or ceilings. Any fittings shall be outside the thermal mass or in an access box.

5.5. Fittings

a) All fittings shall be third-party certified to NSF/ANSI 14 and ASTM F1807 (metal insert), ASTM F1960 (cold expansion), ASTM F2159 (insert polyalloy), or ASSE 1061 (push-fit), in active listings with an organization accredited to ISO/IEC 17065.

5.6. Assembly Tools

a) Tools for assembling PE-RT tubing and fittings shall be part of the manufacturer's cataloged program or tools otherwise explicitly recommended by the manufacturer.

b) Connections shall be assembled in accordance with the manufacturer's installation instructions as well as the assembly specifications in the relevant fitting standard: ASTM F1807, ASTM F1960, ASTM F2159 or ASSE 1061.

5.7. Markings

a) Tubing shall carry the following markings every five (5) feet: Manufacturer's name or trademark; nominal size; 160 psi @ 73.4°F / 100 psi @ 180°F; NSF-rfh; U.M. Code; ASTM F2623/F1807/F2159/F1960; ASSE 1061; ICC-ES PMG; CAN/ULC S101 (ANSI/UL 263); CLASSIFIED UL FIRE RESISTANCE; ULC S102.2; ASTM E84; PE2708 (material designation code); NOT FOR POTABLE USE; manufacturing date; MADE IN CANADA; footage mark.

b) Fittings shall be marked with the manufacturer's designation and certification markings.

5.8. Packaging

a) Coiled pipe shall be shipped in protective packaging marked with product name and size.

b) Straight lengths shall be packed in opaque UV-resistant bags.

c) Fittings shall be shipped in protective packaging marked with product name and size.

5.9. Accessories

a) Circuit valve actuators must be designed for each circuit and activated by heat. They must be supplied by the piping manufacturer.

6. Execution

6.1. Acceptable Installers

a) Installation shall be performed by qualified laborers trained in the procedures of PE-RT radiant heating and/or cooling systems and appropriately licensed for the jurisdiction where the installation will take place.

b) Installers must comply with all manufacturer's technical guidelines.

6.2. Inspection

a) Verify that all surfaces and supports, already installed under other sections, comply with the manufacturer's directives. Do not proceed until unsatisfactory conditions are corrected.

b) Beginning of installation means acceptance of existing conditions.

6.3. Radiant heating system installation

a) Install in accordance with manufacturer's published installation manual and/or published guidelines and final drawings. All notes on drawings shall be followed.

b) Fittings and manifolds must be accessible for maintenance except where fittings were done for repairs, in which case, they must be done in accordance with the piping manufacturer's directives.

c) Pipe protectors must be used in places where the pipe enters or exits a concrete slab.

d) At the time of installation of each circuit of pipe, all circuits shall be labeled to indicate circuit length, serviced area, and whether it is a supply or a return.

e) The heating system should not be put into operation until the poured concrete thermal mass has cured a minimum of 28 days, unless otherwise specified and approved by the thermal mass supplier.

6.4. Quality Control

a) Filling, Testing & Balancing: Testing shall comply with codes and where required, shall be witnessed by the building official.

b) Pressure gauges used in testing and balancing shall show pressure increments of 1 psig and shall be located at or near the lowest points in the distribution system. Pressure shall be maintained and monitored during the installation of the thermal mass. If any leak is detected during the installation of the thermal mass, the leak must be found immediately, and the area cleared for repair using the piping manufacturer-approved repair coupling.

c) Air Test
- Charge the completed, yet unconcealed pipes with air at a minimum of 40 psig.
- Do not exceed 150 psig.
- Use liquid gas detector or soap solution to check for leakage at manifold connections.

d) Water test
- Purge air from tubing.
- Charge the completed, yet unconcealed tubing with water.
- Take necessary precautions to prevent water from freezing.
- Check the system for leakage, especially at all connection joints.
- Perform a preliminary pressure test pressurizing the system to the greater of 1.5 times the maximum operating pressure or 100 psig for 30 minutes.
- As the tubing expands, restore pressure, first at 10 minutes into the test and again at 20 minutes.
- At the end of the 30-minute preliminary test, pressure shall not fall by more than 8 psig from the maximum, and there shall be no leakage.

e) After successfully performing the preliminary pressure test, perform the main pressure test immediately.
- The test pressure shall be restored and continued as the main test for 2 hours.
- The main test pressure shall not fall more than 3 psig after 2 hours.
- No leakage shall be detected.

f) Pressure shall be maintained and monitored during installation of the thermal mass.
- If any leak is detected during installation of thermal mass, leak shall be found immediately, and the area cleared for repair using manufacturer's approved repair coupling.
- Retest before covering repair.

g) Complete inspection.

6.5. Cleaning

a) Clean exposed surfaces upon completion of installation using clean, damp cloth. No cleaning agents shall be used.

b) Comply with manufacturer’s recommendations.

6.6. Protection

a) Protect installation throughout construction process until date of final completion.

b) Replace damaged components that cannot be repaired.

END OF SPECIFICATION